Impact of Robustness of Supply Chain on its Performance - An Empirical Study

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Abstract— Robustness of supply chain is rapidly expanding due to mitigation and reduction in the risk of unexpected and destructive events in the companies. As it is impossible for companies to resume their business post major crisis, the prediction of environmental factors that surround the companies paved way for development of a disaster recovery plan. 80% of the companies suffer from business interruptions and lack clarity in disaster management plan. A conceptual model was developed and validated based on supply chain management and supply chain robustness. A structured questionnaire was developed and administered to the supply chain managers. The survey data was collected from 126 organizations of the automotive sector. Structural equation modeling (SEM) techniques were employed to test the hypotheses. The study indicates that the robustness of Supply chain has a positive impact on the performance of the supply chain.

Keywords — *Supply chain management, Confirmatory factor analysis, Robustness of supply chain, Structural equation modelling, Exploratory factor analysis.*

JEL classification — C0, C4, C5, Y1, Y9, Z0.

1. Introduction

Brutal competitions in today's global supply chain have forced business enterprises to focus attention on their supply chains. Measure and develop a novel RDO (Robust Design Optimization) approach to assure service level rate requirements and minimize total service level costs. A supply chain system design must maintain its efficiency over time while coping with the uncertainties. Modern supply chains are inherently complex comprising multi-echelon, geographically is jointed entities competing to serve consumers [17, 19]. Traceability is becoming an increasingly urgent requirement and high value goods [20]. Strategic and reputational competitive issues arise from these risks and lack of transparency. A major tenet in the global supply chain (SC) system is to ensure continuous quality, reliability, resilience, and management improvement through strategic planning, operational tools, mathematical modeling, and optimization. SC systems risk management has increased the global concern in recent years Supply chain practice and strategy is also facing emergent pressures to consider and certify supply chain sustainability. Current supply chains rely heavily on centralized, sometimes disparate and stand-alone information management systems, which are within organizations. Supply chain entities require significant trust for relying on one single organization or broker for storing their sensitive and valuable information [1]. Single point failure is another disadvantage of centralized information systems which leaves the whole system vulnerable to error, hacking, corruption, or attack [5].

2. Literature Review

Not only are business dimensions of the supply chain important for sustainable supply chains, but expanding the focus to environmental and social dimensions has made for a more generalizable and holistic perspective on the supply chain [8, 9]. The promising features of block chain technology might be a panacea for such complexity in the triple-bottom-line of sustainability: economic, social, and environmental bottom lines. Thus, capturing and identifying sustainable supply chain examples can exemplify the breadth of block chain technology application. Block chain technology can support data collection, storage, and management. Openness, transparency, neutrality, reliability, and security for all supply chain agents and stakeholders can exist in this technological context [1]. Economically, adopting block chain technology can benefit a firm and its supply chain. Block

chains can result in supply chain dis-intermediation where fewer tiers result in transaction costs and time reduction, reducing business waste in the supply chain [34]. Block chain technology can share instantly every modification of the data, allowing for potentially rapid deployment of products and processes while minimizing human errors and transaction times. Block chain technology can ensure the safety and authenticity of the data, which will reduce the cost of preventing data from deliberate and capricious alteration increasing supply chain risks and reducing business reliability [13, 14, 15, 16]. Pioneering companies realized the competitive advantage of transparency [34], which results in increasing customers' trust to purchase more and benefit the firm financially.

Another environmental supply chain sustainability example is related to carbon tax. With block chain technology, tracing the footprint of products of particular company becomes easier. Block chain technology can help reduce carbon emissions in the journey of products by providing the fundamentals for supply chain mapping [3]. SCEnAT 4.0 (The Supply Chain Environmental Analysis Tool) is a new tool that integrates new technologies such as IoT (Internet of Things), A.I (Artificial Intelligence), block-chain, and Machine Learning (ML) to manage big data and link organizations in the supply chain more effectively to support industry 4.0 policies, carbon reduction, and green assessments. Block chain technology also has the potential to transform carbon assets trading. China is developing a green assets block chain-based platform that helps organizations and facilitate carbon asset development and trading. Transparent, secure and real-time information on the block chain gives organizations the opportunity to cooperate and trade their carbon assets in a more efficient way in the green assets markets.

3. Block-chain and sustainable supply chains

Sustainable supply chains have gained significant interest [8, 9]. Expanding the focus to environmental and social dimensions has made for a more generalizable perspective on the supply chain. The promising features of block-chain technology might be a panacea for such complexity. A block-chain-based supply chain provides better assurance of human rights and fair work practices. Block-chains can prevent corrupt individuals, governments or organizations from seizing assets of people unfairly. Pioneering companies realized the competitive advantage of transparency [34]. Block-chain technology also aids in environmental supply chain sustainability. Block-chain benefits the emission trading process by improve emission trading schemes (ETS) efficacy. With the application of block-chain technology, fraud can be avoided due to the fidelity and transparency of block-chain. Block-chain can improve the recycling. RecycleToCoin is another block-chain application that enables people to return plastic containers [10].

Figure 1: Traditional Supply Chains vs. Block-chain Supply Chains

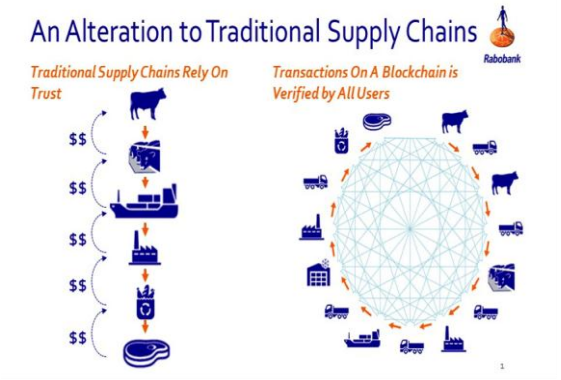

Figure 1: Traditional Supply Chains Vs. Block-chain Supply Chains Source: Rabobank

Figure 2: Sustainable Block-chain

Figure 2: Sustainable Block-chain Source: IBM

4. Hypothesis

Robustness of Supply Chain has a positive impact on the performance of supply chain.

5. Limitations of Research

The limits of research include both the scientific boundaries which are related to the methodology of research and its variables.

6. Research Methodology

6.1. Research Sampling

A total of 158 automotive firms were contacted of which 126 automotive firms accepted to participate.

6.2. Collection of Data

Primary data collected based in part on direct/personal semi-structured in-depth interviews (qualitative data) and in part on questionnaires (quantitative data). A mixed methods approach was used in the data-collection phase to understand, map out and investigate from different standpoints

(a) The research problem and proposed relationships.

(b) The nature of the automotive sector.

The study combines both qualitative and quantitative approaches [37].

6.3. Development of Questionnaire

The questionnaire list, which includes a set of terms that measure the variables of study based on the five-dimensional Likert scale, is designed to identify the impact of effective implementation of information security initiatives on both supply chain operations and performance. Measurement items used in this study were either developed from literature or adopted from previous studies. Identification and validation of newly generated items were done in two stages: Item generation through literature review and Pilot testing using Q-sort methodology [21].

6.4. Transactions of credibility and consistency

The Cronbach alpha coefficient was used to measure the stability coefficient (reliability score) at the level of all variables related to the impact of the effective implementation of information security initiatives on the performance of the supply chain. The internal consistency coefficient of the data was also measured.

6.5. Results of stability and validity tests

The validity of all items at the level of the total dimensions where the internal consistency coefficients at the level of 0.01.These ranged between 0.52 to 0.91, which reflects the strength of the values of the transactions and their proximity to the correct one, the relationship between the different dimensions and the extent to which they represent the dimensions of the supply chain robustness, which greatly reflects the degree of credibility of these dimensions. Based on 126 responses, all the constructs were tested for reliability and validity.

Table 1: Robustness of supply chain as a dependent variable using the Cronbach alpha co-efficient and Pearson correlation

Statements	Coefficient of Internal consistency	Cronbach alpha
The organization has documented the measures to be taken then an emergency or disaster occurs, covering crisis communications, business process and it resources recovery.	0.73**	0.881
The organization has a written disaster recovery plan for systems, data and telecommunications.	0.86**	
The organization has a regular and audit-able maintenance schedule for all of the business continuity plan components.	0.57*	
The organization would return to normal operations in short order, if a serious security breach were to happen.	0.78**	
The organization has procedures that ensure speedy resumption of essential operations following system failure/interruption.	0.70**	
** Indicates a significant level of 0.01		
* Indicates a significant level of 0.5		

Table 2: Performance of supply chain as a dependent variable using the Cronbach alpha co-efficient and Pearson correlation

Statements	Coefficient of Internal consistency	Cronbach alpha
The supply chain is able to respond to changes in market demand without overstocks or lost sales.	0.80**	0.860
The supply chain is able to leverage the competencies of our partners to respond to market.	0.59*	
The supply chain is able to forecast market demand.	0.60**	
The supply chain has reduced in-bound lead-times.	0.92**	
The supply chain ensures non-value added time reduction in the pipeline.	0.69**	
The supply chain ensures that processes are streamlined throughout the supply chain.	0.89**	
The supply chain system increases our order fill rate.	0.69**	
The supply chain system increases our inventory turns.	0.75**	
The supply chain system reduces our safety stocks.	0.76**	
The supply chain system reduces our inventory obsolesces.	0.54*	
The company receive timely delivery of materials / components /products from our partners.	0.77**	
The company receive speedy delivery from our partners.	0.79**	
The company receive quality delivery from our partners.	0.73**	
The supply chain system reduces warehousing costs.	0.88**	
The supply chain system reduces our product warranty claims.	0.60**	
The supply chain system reduces inventory-holding cost.	0.87**	
The supply chain system reduces inbound and outbound costs.	0.61**	
The supply chain has short order fulfilment lead times.	0.60**	
The supply chain has short order-to-delivery cycle time.	0.67**	
The supply chain has fast customer response time.	0.88**	
** Indicates a significant level of 0.01		
* Indicates a significant level of 0.5		

Table 3: Simple linear regression model to determine the significance of the impact of robustness of supply chain on performance of supply chain

Independent variable	Estimated parameters βi	t - test		F- test		$R^{\wedge 2}$	r
		Value	Significance	Value	Significance		
Constant part	0.765	3.252	**.00	000...	.0..0**	%5000	.07.0
Supply chain robustness	.00.0	505.6	**.00				
** Indicates a significant level of 0.01							

7. Summary

It is possible for the managers of the automotive supply chain to benefit from the proposed model by the researcher in trying to work on the supply chain robustness, which improves the performance of the supply chain in general. Automotive supply chain managers can take care of implementing an integrated portal that protects information assets from unauthorized access, disclosure, data modification or destruction by setting up the correct password mechanisms and keeping copies additional and maintain network security.

8. Further scope of the study

Researcher proposes the following points to guide other researchers as areas for future research:

1. The impact and interaction of several variables such as the size of the organization, the structure of the organization and the complexity of information technology in the application of supply chain operations between organizations.

2. The impact of the educational level and the age of supply chain managers on the extent to which they accept the application of supply chain robustness.

3. The impact of the supply chain robustness on supply chain performance to companies working in other industrial sectors and companies that have worked in the service sector and to know the impact on supply chain performance.

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